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INTENSE ION BEAM FROM A MAGNETICALLY INSULATED DIODE WITH AN ACTIVE ANODE SOURCE

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A magnetically insulated diode using an active anode plasma ion source was developed and thoroughly characterized. In this extraction-geometry ion diode, an anode plasma of annular shape and 30 cm diameter is formed independently of the injector voltage pulse. The anode plasma is produced by inductive voltage breakdown of a radially expanding gas cloud supplied by a fast puff valve. This diode was driven by the low voltage (<200 kV), long pulse (>1 μs) LONGSHOT II generator. It was capable of producing prompt ion current turn-on, long pulse (1 μs), high current density (>100 A/cm^2) proton beam output at 70-150 keV when using hydrogen gas. Other characteristics of this diode include: extraction of a pure proton beam within the 20% measurement uncertainty; diode voltage pulse shape (flat, decreasing or increasing in time) and pulse length control by injection of the anode plasmas with differing density and/or timing; capable of flat or increasing impedances; an effective gap closure velocity of < 2 mm/μs during the main power pulse;

low neutral to plasma density ratio at the gap; up to 5 J/cm^2 energy density deposited over a beam extraction area of 300 cm^2; more than $1x10^{17}$ particles per pulse with > 60 keV; global beam uniformity better than ±35% (10% on a 1 cm length scale); ion current efficiency of at least 40%; and typical divergence of <3° half angle. With a nitrogen gas puff, beams with similar pulse shapes and current densities to the proton beams were obtained. No major diode components replacement was needed for over 700 shots. The aiming angle of the extracted beam varied in time and space by more than 25° (in the radial direction) when a high ion current density (>60 A/cm^2) was extracted and plasma was present in the diode when the high voltage pulse was applied. It was possible to eliminate the aiming angle variation for high current density beams by applying the high voltage pulse before plasma reached the gap or by using a conducting mesh anode.